RECORD OF DECISION SUMMARY

SACO MUNICIPAL LANDFILL
SACO, MAINE

September 2000

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DECLARATION FOR THE RECORD OF DECISION

A. SITE NAME AND LOCATION

Saco Municipal Landfill Superfund Site
Saco, York County, Maine
CERCLIS Identification Number: MED9800504393
PRP Lead
Entire Site, No Operable Units

B. STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Saco Municipal Landfill Superfund (Site), in Saco, Maine, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (CERCLA), 42 USC § 9601 et seq., and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300 et seq., as amended. The Director of the Office of Site Remediation and Restoration (OSRR) has been delegated the authority to approve this Record of Decision.

This decision was based on the Administrative Record, which has been developed in accordance with Section 113 (k) of CERCLA, and which is available for review at the Dyer Memorial Library in Saco, Maine and at the United States Environmental Protection Agency (EPA) Region 1 OSRR Records Center in Boston, Massachusetts. The Administrative Record Index (Appendix G of this Record of Decision (ROD)) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based.

The State of Maine concurs with the Selected Remedy.

C. ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

This ROD sets forth the final remedy at the Saco Municipal Landfill (SML) Site, which involves monitored natural attenuation of the groundwater contamination down-gradient of Landfill Areas 3 and 4; institutional controls, and long-term groundwater, surface water, and sediment monitoring and evaluation. Based on site evaluations and information collected to date, it is anticipated that monitored natural attenuation will reduce concentrations of arsenic, manganese, and benzene in groundwater down-gradient of Landfill Areas 3 and 4 to their respective remediation goals within 60 to 100 years. The selected remedy is a comprehensive approach for the Site that addresses all current and potential future risks caused by groundwater contamination. Measures to address the source of contamination were implemented as part of a NTCRA.

The major components of this remedy are:

- Monitoring of groundwater, surface water, and sediments to demonstrate that natural attenuation is protective;
- Establishment of an evaluation program to measure the progress of natural attenuation toward achieving the cleanup goals; and
- Institutional Controls

The selected response action addresses principal and low-level threat wastes at the site by:

- Stabilizing arsenic, manganese, and benzene concentrations in groundwater at or below acceptable levels over a 60 to 100 year period via natural attenuation processes;
- Reducing concentrations of arsenic and manganese in surface water and sediment through reduction of arsenic and manganese concentrations in groundwater; and
- Restricting current and future land and groundwater uses.

E. STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy does not satisfy the statutory preference for treatment as a principal element because the selected remedy was considered to have comparable protection of human health and the environment while being more cost effective.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and/or land use restrictions are necessary), a review will be conducted every five years after initiation of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

F. SPECIAL FINDINGS

Issuance of this ROD embodies specific determinations made by the Regional Administrator or her designee pursuant to CERCLA. No special findings (i.e. ARAR waivers) under section 121(d)(4) of CERCLA are included in this ROD.

G. ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this Record of Decision. Additional information can be found in the Administrative Record file for this site.

1. Chemicals of concern (COCs) and their respective concentrations.

2. Baseline risk represented by the COCs.

3. Cleanup levels established for COCs and the basis for the levels.

4. How source materials constituting principal threats are addressed.

5. Current and reasonably anticipated future land assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.

6. Potential land and groundwater use that will be available at the Site as a result of the selected remedy.

7. Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.

8. Key factor(s) that led to selecting the remedy (i.e. describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria; highlighting criteria key to the decision).

H. AUTHORIZING SIGNATURES

This ROD documents the selected remedy for the SML Site. This remedy was selected by USEPA with concurrence of the Maine Department of Environmental Protection (MEDEP).

U.S. Environmental Protection Agency

By: Patricia L. Meaney   Date: 9/29/00

Patricia L. Meaney
Director
Office of Site Remediation and Restoration
Region 1

PART 2: THE DECISION SUMMARY

A. SITE NAME, LOCATION, AND BRIEF DESCRIPTION

Saco Municipal Landfill Superfund Site
Saco, York County, Maine
CERCLIS Identification Number: MED9800504393
PRP Lead
Entire Site, No Operable Units

The Saco Municipal Landfill (SML) Superfund Site is located on Foss Road, York County, Maine (see Figure 1). The Site occupies 90 acres, of which four separate landfill areas (Areas 1, 2, 3, and 4) comprise approximately 30 acres. The Site is owned by the City of Saco (the City) and the four landfill areas were operated by the City from 1963 until 1988. In 1990, the United States Environmental Protection Agency (EPA) placed the SML on the National Priorities List (NPL).

The Site consists of four distinct waste disposal areas (Areas 1, 2, 3 and 4) and is bordered by wooded areas in all directions except for an open sand and gravel pit to the southwest of Area 4. The four landfill areas (Areas 1, 2, 3, and 4) comprise approximately 30 acres. Private residences are located to the north and east of the Site. Sandy Brook flows through the Site with Landfill Areas 1 and 2 on the east and Areas 3 and 4 on the west side of the brook. The City currently operates a transfer station and compost area in the portion of the site located north of Area 1 and Foss Road. The location of the site and key site features are shown on Figures 1 and 2.

A more complete description of the Site can be found in Section 3 of the RI Report (Woodard & Curran, October 1998).

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

1. History of Site Activities

Numerous investigations have been conducted at the Site; these are summarized in Table 1. Environmental investigations were initiated in 1973 by the City of Saco to evaluate their waste disposal practices and options that would minimize/prevent leachate generation and improve operating efficiency. In the mid-1970s, the investigations were primarily focused on operational issues. In the later part of the 1970s into the 1980s, the focus of the investigations shifted from operational issues to potential environmental concerns.

The early environmental investigations identified groundwater and surface water quality problems thought to be caused by leachate outbreaks at the landfill. In response to suspected contamination in nearby shallow wells, the municipal water supply was extended to residents along Buxton Road (Route 112) in 1975.

At the start of the remedial investigation and feasibility study (RI/FS), there were four distinct landfills at the Site. Each landfill has a unique operating history:

- **Area 1** is approximately 10 acres in size and was the original municipal landfill operating as an open dump beginning in the early 1960s. Material reportedly disposed of in this landfill includes municipal waste and sludge from the Factory Island treatment facility. This area was closed in 1974 and regraded and covered with a clay cap in 1976. The integrity of the clay cover became questionable and an additional 18 inches of compacted clay with six inches of seeded topsoil was placed on the landfill in 1985.

- **Area 2** is approximately 6 acres in size. This landfill area began operation in 1974 accepting industrial waste, brush, and construction demolition debris. During this time, municipal waste was disposed of in Landfill Area 4. In 1981, MEDEP issued an Administrative Consent Agreement and Enforcement Order to the City for the closure of the entire SML. This closure was to be conducted in conformance with the Maine Solid Waste Management Regulations. Design for the closure of Area 2 was initiated in March 1984 and included the construction of an 18- to 20- inch clay cover with four inches of topsoil, a clay slurry wall along the northern edge of the landfill, and a leachate collection and recirculation system. The design was approved by the MEDEP on May 22, 1985 and the closure was completed before the end of 1985. Problems with the leachate recirculation system were encountered within the first year of operation. In the winter of 1986, the leachate system failed resulting in leachate reaching Sandy Brook. Currently the recirculation system is not operating and the City, with the approval of EPA and MEDEP, is pumping leachate from the collection system wet well located west of Area 2 and discharging it to the on-site infiltration basin.

- **Area 3** is approximately 1 acre in size and is located adjacent to the northwestern edge of Area 4. Area 3 was developed around 1985 as an industrial waste area for several local industries. Material was temporarily stored in this area until it could be incinerated at the Maine Energy Recovery Company in Biddeford, Maine. Removal and off-site disposal of a majority of this material was completed in December 1992 with the approval of MEDEP. This landfill was the subject of an early cleanup action implemented as a non-time-critical removal action (NTCRA); currently this area is capped with a low permeability cover system.

  Area 4 comprises approximately 13 acres, including the solid waste boundaries as identified through closure activities. This area operated between 1974 and 1989, accepting primarily municipal waste. Sludge from the tannery wastewater treatment system was reportedly disposed of in this area. This landfill was the subject of an early cleanup action implemented as a non-time-critical removal action (NTCRA) and is currently this area is capped with a low permeability cover system.

A more detailed description of the Site History can be found in Section 1.3 of the RI Report.

2. History of Federal and State Investigations and Removal and Remedial Actions

In 1980, allegations of illegal dumping of hazardous waste at the SML prompted both the MEDEP and EPA to initiate a Preliminary Site Assessment and Site Inspection that included environmental sampling programs at the landfill. These investigations included sample collection and analysis and confirmed the presence of leachate contamination in groundwater and surface water. In 1981, the MEDEP issued an Administrative Consent Agreement and Enforcement Order that initiated closure and closure related studies at the Site. A Draft Hazard Ranking System (HRS) package for the Site was prepared and submitted to USEPA in 1987. The Site was officially listed on the NPL on February 21, 1990.

From 1992 - 1994 EPA performed a study of the study of the groundwater at the SML. This study resulted in a United States Geological Survey (USGS) Publication entitled: Geohydrology, Water Quality, and Conceptual Model of the Hydrological System, Saco Landfill Area, Saco, Maine (USGS 1995). EPA also prepared a report summarizing Site conditions entitled: Site Summary Report for the START Initiative (HNUS 1994).

In 1995, the City of Saco entered into an Administrative Order with the EPA to conduct an RI/FS at the Site. To comply with the Order, and to address data gaps identified during previous investigations, the City developed a Phase 1A field program. The Phase 1A investigation was initiated in November 1995, and included groundwater, surface water, sediment, surface soil, and air sampling; test pit investigations, installation of monitoring wells, residential well sampling and a geotechnical investigation of the existing covers at Landfill Areas 1 and 2. Additional fieldwork was conducted in May 1996, Summer 1996, and Fall 1996 to supplement the November 1995 sampling program and support the RI and NTCRA for the Site.

The Phase 1A RI determined that Landfill Areas 3 and 4 were leaching pollutants into the groundwater beneath the Site, resulting in the discharge of contamination to a wetland seep area, and into nearby Sandy Brook surface waters and sediments. To address the source of contamination for the contaminated groundwater, EPA signed an Action Memorandum in 1996 to initiate a non-time-critical removal action (NTCRA) at the Site. The purpose of the NTCRA was to consolidate and cap contaminated soils and wastes within Landfill Areas 3 and 4. Figure 3 presents an overview of the NTCRA actions. The NTCRA, which was completed at the Site in 1999, consisted of the excavation of soils/sediments of several groundwater seeps that contained elevated levels of arsenic and placement of these materials beneath the cap for Landfill Areas 3 and 4; excavation of several pockets of solid waste (approximately 5,000 cubic yards) outside the footprint of the existing landfills and consolidation of this solid waste into Landfill Areas 3 and 4; design and construction of a multi-barrier landfill cap over Landfill Areas 3 and 4; development of land use restrictions that will restrict future use of the Site; and creation of a new on-site wetlands area southeast of Landfill Area 4 to compensate for the wetlands impacted by the cap construction.

The Final Phase 1A RI report for the Site was completed in October 1998 and included a Human Health Risk Assessment (HHRA). An Ecological Risk Assessment (ERA) for the site was conducted over a two-year period beginning in November 1997 and the ERA Report was completed in February 2000. A Supplemental RI and United States Geologic Survey (USGS) geologic and hydrologic survey were conducted at the Site between July 1997 and October 1998 as part of the FS to supplement data collected in the Phase 1A RI and further characterize the nature and extent of contamination at the Site. The Final FS Report, which included a Supplemental RI Report for the Site, was completed in July 2000.

A summary of the CERCLA investigations at the Site is included in Table 1.

3. History of CERCLA Enforcement Activities

The CERCLA enforcement activities at the Site are summarized below:

- In February 1995, EPA issued special notice to the City of Saco as the owner/operator of the landfill and to 14 industrial generators seeking their participation in a remedial investigation/ feasibility (RI/FS) for the Site. The generators refused to participate in the RI/FS. The City, however, agreed to conduct the RI/FS on its own pursuant to a September 1995 Administrative Order by Consent (AOC).

- In September 1996, EPA again issued special notice to the potentially responsible parties (PRPs), this time seeking their performance of a Non-Time Critical Removal Action (NTCRA). As part of a May 1997 Administrative Order by Consent, the City of Saco agreed to perform the work and to pay for EPA's oversights cost in excess of $ 400,000. The remaining settling parties agreed to pay the City of Saco approximately $1 million to help the City pay for the work. An accompanying May 1997 administrative cost agreement released all of the Settling Parties from their liability for past costs of roughly $1.5 million. One of the two non-de minimis, Non-Settling Parties has filed for bankruptcy protection. The other, Garland Manufacturing Company, has to date refused to negotiate a settlement acceptable to the EPA.

- After issuance of the RI/FS AOC, EPA determined that Joseph Herman Shoe Corporation, one of the industrial generators who refused to participate in the initial AOC and the Order for the NTCRA, was entitled to a de minimis settlement. In September 1999, EPA entered into a de minimis settlement with this Corporation. Through this settlement this Corporation resolved its alleged liability under Sections 106 and 107 of CERCLA for activities conducted with regard to this Site.

The City of Saco has been actively involved with the remedy selection process for this Site. As the primary PRP associated with this site, the City performed the RI/FS and provided comments on EPA's proposed remedy for the Site.

C. COMMUNITY PARTICIPATION

Throughout the Site's history, community concern and involvement has been high. The EPA, MEDEP, and the City have kept the community and other interested parties apprized of Site activities through informational meetings, fact sheets, press releases and public meetings. Below is a brief chronology of public outreach efforts.

- On December 6, 1995 EPA, MEDEP, and the City held an informational public meeting in Saco, Maine to describe field activities planned at the Site.

- In January 1996, EPA released a Community Relations Plan that outlined a program to address community concerns and keep citizens informed about and involved in remedial activities.

- On July 26, 1996, EPA published a notice and brief analysis of a proposed early cleanup action or NTCRA in the Portland Press Herald and made the plan available to the public at the Dyer Memorial Library in Saco, Maine.

- On July 31, 1996, EPA, MEDEP, and the City held an informational public meeting in Saco, Maine to address the proposed NTCRA for the Site, which included the cover system for Landfill Areas 3 and 4, and the excavation of sediments from the seep and Sandy Brook as part of the NTCRA. A formal public comment period on the Proposed Plan was held between August 1 and August 31, 1996, and a formal public hearing was held on August 21, 1996 to discuss the proposed NTCRA and accept formal public comment. A transcript of this meeting, the comments received, and the Agency's response to comments are included in the Responsiveness Summary, which was part of the September 1996 Action Memorandum.

- On May 29, 1997, EPA, MEDEP, and the City held an informational public meeting in Saco, Maine to discuss the landfill cap construction activities and the address the status of the RI/FS. Follow up meetings to address the status of the construction activities and RI/FS were held in November 1997, and on May 27, 1998.

- On August 1, 2000, EPA held an informational meeting to discuss the results of the Remedial Investigation and the cleanup alternatives presented in the Feasibility Study and to present the Agency's Proposed Plan to a broader community audience than had already been involved at the Site. At this meeting, representatives from EPA, MEDEP, and the City answered questions from the public.

- On August 1, 2000, EPA made the administrative record available for public review at EPA's offices in Boston and at the Dyer Memorial Library in Saco, Maine. This will be the primary information repository for local residents and will be kept up to date by the EPA.

- From August 2, 2000 to September 2, 2000, the Agency held a 30-day public comment period to accept public comment on the alternatives presented in the Feasibility Study and the Proposed Plan and on any other documents previously released to the public.

- On August 16, 2000 EPA, MEDEP, and the City held a formal public hearing in Saco, Maine to discuss the Proposed Plan for the remedial action at the Site and accept formal public comment. A transcript of this meeting, the comments received, and the Agency's response to comments are included in the Responsiveness Summary, which is part of this ROD.

D. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

The selected remedy for the Site was developed by combining components of source control and management of migration alternatives to obtain a comprehensive approach for site remediation. This remedy will address the groundwater and surface water impacted by the Landfills 3 and 4. The RI and Risk Assessments concluded that the groundwater impacted by Landfill Areas 3 and 4 was the only pathway that required remedial action after completion of the NTCRA.

The NTCRA and previous State of Maine Solid Waste Program Solid Waste Closure activities were the primary source control actions at the Site. The NTCRA comprised of the removal of contaminated sediments and capping of Landfill Areas 3 and 4. The State of Maine Solid Waste Closures comprised the placement of clay caps over Landfill Areas 1 and 2 along with a slurry wall and leachate collection system around Landfill Area 2. These actions have addressed principal threats at the Site posed by these sources.

In summary, the response action contained in this ROD addresses the remaining threats to human health and the environment posed by the Site. This remedy represents the first and only operable unit anticipated for the SML Site.

E. SITE CHARACTERISTICS

The sources of contamination, release mechanisms, exposure pathways to receptors for contaminated groundwater as well as other site specific factors, are diagramed in a Conceptual Site Model (CSM). See Figure 4 for detail. The CSM is a three-dimensional "picture" of migration routes and potential receptors. It documents current and future site conditions and shows what is known about human and environmental exposure through contaminant release and migration to potential receptors. The risk assessment and potential response actions for contaminated groundwater, surface water and sediments are based on this CSM.

The CSM for the SML is based on the Final Phase 1A Report (Woodard &Curran 1998a). This report concluded that Landfill Areas 3 and 4 were causing reducing conditions that mobilized the naturally occurring arsenic and manganese into the groundwater beneath the Site, resulting in the discharge of contaminants to a wetland seep area and into the surface water and sediments of Sandy Brook. Based on these findings, the City of Saco, under the supervision of EPA and MEDEP, implemented an early cleanup action which consisted of consolidating and covering the contaminated soil, sediments and landfill waste with an impermeable cap. The purpose of this early cleanup action was to remove the source component of contamination and prevent direct exposure to contaminated soils. With the successful completion of the NTCRA in 1998, the CSM was refined to focus on residual groundwater, surface water and sediment contamination.

Section 2 of the FS Report (Woodard & Curran, July 2000) contains an overview of the Supplemental RI performed at the Site between July 1997 and October 1998 and supplements information presented in the Final Phase 1A RI Report (Woodard & Curran, 1998a). The Supplemental RI included additional sampling to further define the nature and distribution of contamination and to refine the site conceptual model. The significant findings of the RI and the Supplemental RI are summarized below.

1. Site Setting, Geology and Hydrogeology

The SML lies in the coastal lowlands of southern Maine. Topography is low and undulating, shaped by long periods of glacial erosion and deposition. The Saco River is 2.3 miles west and south of the study area. Sandy Brook, a small perennial tributary to the Saco River flows through the study area with Landfill Areas 1 and 2 to the east and Areas 3 and 4 to the west and has deeply incised the coastal unconsolidated sediments. The Site is bordered by wooded areas in all directions with the exception of a sand and gravel quarry southeast and adjacent to Area 4. A small unnamed tributary to Deep Brook flows to the south of Area 1off-site; private residences are located to the north and east of the Site.

The geology of the SML includes a discontinuous sequence of unconsolidated glacial deposits overlying bedrock. Specifically, the RI identified that the overburden soils at the SML are comprised of four unconsolidated deposits. These include from bottom to top, a glacial till, a coarse-grained glaciomarine (sand and gravel) deposit, a thick fine-grained glaciomarine silt and clay, and a fine sand unit (see figure 4). In general, each of these units is saturated and, based on their location and characteristics, plays an important part in the functioning of the hydrogeologic system at the site.

The bedrock geology of the Saco Landfill consists of a single rock type with the majority of fractures occurring in the top 20 ft. Observations made during drilling indicate that the bedrock becomes more competent with depth and groundwater flow between the bedrock fractures moves upward towards the overburden.

A total of 27 monitoring wells were installed as part of the RI. The data collected from these monitoring wells identified that Landfill Areas 3 and 4 contribute to the greatest volume of contaminants to groundwater on-site. The absence of a subsurface clay layer, which is found beneath Landfills Areas 1 and 2, allows contaminated leachate to migrate from the Landfill Areas 3 and 4 into the deeper bedrock areas underlying the site. To address this principal source of contamination, EPA initiated a NTCRA that included the consolidation and capping of contaminated soils and wastes in Areas 3 and 4.

To further assess the distribution of contaminants southeast of Landfill Areas 3 and 4, the USGS performed additional field studies that included the installation of additional monitoring wells in this portion of the Site and detailed analyses of whole-rock samples to assess the primary chemical and physical processes influencing the distribution of contamination within the aquifer. An additional goal of the USGS study was to characterize the flow path from the landfill to the stream to enable geochemical modeling of the contaminant distribution in this system.

The USGS wells were sampled in December 1997 and June 1998 along with selected existing wells. The samples were analyzed for inorganic parameters as part of the Pre-ROD groundwater sampling program. Appendix F of the FS includes results of the December 1998, June 1999, and November 1999 sampling programs.

Fourteen soil and rock cores from the contaminated portion of the aquifer downgradient of Landfill Areas 3 and 4 were collected by the USGS and subjected to laboratory tests to mimic the leaching of inorganics from the native rock. The USGS studies characterized the chemical mechanisms occurring in the aquifer by which contaminants are leached from the rock to provide a basis for estimating the time that may be required to improve groundwater quality beneath and downgradient of the Landfill.

The hydrogeological investigation and modeling efforts at the Site indicate that groundwater flow is controlled by the bedrock and surface topography of the Site. Groundwater flow is directed radially away from a bedrock high located just to the west of Landfill Areas 3 and 4. The groundwater flowing from the northern boundary of the landfill gradually turns to the east and then turns again to the south-southwest, paralleling the flow of Sandy Brook. The groundwater at the southeast toe of the landfill flows generally southeast toward, and discharges to, Sandy Brook.

Groundwater and surface water interactions at the Site are governed by the discontinuous nature of the silt and clay deposits of the Presumpscot Formation (Fm.) and their relationship to the sand and gravel deposits of the lower aquifer (Woodard & Curran, 1998a). The Presumpscot Fm. is present below the portion of the stream between Areas 3 and 4 and Areas 1 and 2. The presence of this clay and silt layer limits the discharge of groundwater to the stream between Areas 1 and 2 and Areas 3 and 4. The Presumpscot Fm. is absent beneath the stream directly downgradient of Areas 3 and 4 allowing for greater discharge to the stream via the higher conductivity sand and gravel deposits.

2. Nature and Distribution of Contamination

This section describes the nature and distribution of contaminants in groundwater, surface water, soil, air, and sediments at the Site, as determined by sampling events conducted bi-annually (Spring and Fall) from 1995 to the present. Comprehensive groundwater, surface water, and sediment sampling data collected through June, 2000 are included in this ROD as Tables 2, 3, and 4, respectively. Groundwater sampling locations are indicated in Figure 5, surface water locations are indicated on Figure 6, and sediment locations are indicated in Figure 7.

Soil:

Surface soils were sampled throughout the Site. Each of the four landfills was treated as a separate area with respect to soil sampling.

Landfill 1: Seven soil samples were obtained to characterize the soils adjacent to Landfill 1. The surface soil of landfill 1 was not sampled due to the presence of a clay cap installed as part of the State of Maine Solid Waste Closure. Obvious drainage areas that may have been subject to erosion and contaminant transport prior to the installation of the cap were targeted for soil sampling. Very low levels alpha-chlordane, dieldrin, heptachlor epoxide, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, fuoranthene, phenanthrene, pyrene, indeno(1,2,3-cd)pyrene, along with trace levels of various VOCs were detected. Beryllium, arsenic, and manganese were also detected at low concentrations in the soils.

Landfill 2: Fourteen surface soil samples were obtained to characterize the soils on and adjacent to Landfill 2. Surface soils on the cap were sampled because leachate had spilled onto the surface of the cap installed as part of the State of Maine Solid Waste Closure when the leachate collection system failed. Stained areas near several stand pipes were targeted for sampling. A similar pattern of contamination with low levels 4,4 DDT, 4,4 DDD, 4,4 DDE, alpha-chlordane, dieldrin, endosulfan II, endrin ketone, gamma chlordane, heptachlor epoxide, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, bis(2ethyl-hexyl phthalate), chrysene, di-n-octylphthalate, fuoranthene, phenanthrene, pyrene, indeno(1,2,3-cd)pyrene, along with trace levels of various VOCs were detected. Beryllium, iron, arsenic, and manganese were also detected at low concentrations in most of the soil samples. Several samples in the area stained by leachate contained higher levels of arsenic (up to 84 mg/kg), iron (up to 610,000 mg/kg), and manganese (up to 10,000 mg/kg).

Landfills 3 and 4: The soil sampling strategy for Landfill Areas 3 and 4 was different due to the fact that these landfills were not capped prior to the start of the RI/FS. Therefore, soils within the landfills as well as adjacent were sampled during the RI. Fifteen soil samples were collected for landfills 3 &4. Trace levels of VOCs and low levels of the pesticides 4,4 DDT, 4,4 DDD, 4,4 DDE, alpha-chlordane, dieldrin, endosulfan II, gamma chlordane, heptachlor epoxide were detected in the soil. Numerous SVOCs were detected, including: 2-methylnapthalane, acenapthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, bis (2ethyl hexyl phthalate), chrysene, di-n-octylphthalate, fuoranthene, phenanthrene, pyrene, indeno(1,2,3-cd)pyrene, Arsenic, berrylium, antimony, iron, and manganese were also detected at low concentration. Chromium, however, was detected in landfill 3 at concentrations up to 110,000 mg/kg. This was an area where chromium containing sludge from the Saco Tannery has been disposed.

Overall, the soils at the site did not contain significant levels of VOCs, SVOCs, pesticides, or PCBs when compared to preliminary remediation goals or background. While several inorganic constituents were also detected, only chromium in Landfill 3 and arsenic in the leachate stained areas of Landfill 2 were significant.

Surface Water:

The surface waters of Sandy Brook, Big Ledge Brook, Deep Brook, an unnamed tributary to Deep Brook, Dubois Pond, and a small stream north of Landfill Area 3 were all sampled as part of the RI.

Landfill 1: An unnamed tributary to Deep Brook and Dubois receive surface water from Landfill 1. The unnamed tributary begins at a leachate seep adjacent to Landfill 1. Two SVOCs and 12 VOCs were detected in the unnamed tributary in the area adjacent to Landfill 1. These levels did not exceed the federal water quality criteria for environmental protection. Iron was detected above AWQC . Low levels of lead were also detected. Only iron was detected above reference criteria in Dubois Pond.

Landfill 2: Five samples within Sandy Brook were collected to characterize the potential surface water impacts from landfill 2: Two pesticides, one SVOC, and two VOCs were detected at concentrations well below the respective AWQC protective of aquatic life. Iron has been sporadically detected above the AWQC in this area.

Landfills 3 and 4: North of Landfills 3 and 4 is a small unnamed stream. No constituents were detected above reference criteria in this surface water. Numerous locations with Sandy Brook from the landfill road extending downstream past the confluence with Big Ledge Brook have been sampled to characterize the impact of Landfill Areas 3 and 4. Trace levels of a few SVOCs and VOCs were detected in the surface water. Iron, arsenic, and manganese were all detected at concentrations above reference criteria in the section of Sandy Brook between the landfill access road and the confluence with Big Ledge Brook. Concentrations rapidly approach reference criteria past the confluence of Sandy Brook and Big Ledge Brook.

Air:

Ambient air was sampled during the RI. Low levels of several VOCs were detected in the air sample.

Sediments:

Landfill1: The sediments of the unnamed tributary to Deep Brook were sampled as part of the RI. VOCs, SVOCs, pesticides, and PCBs were not detected above reference criteria. Arsenic (up to 105 mg/kg), iron (up to 31,600 mg/kg), and manganese (1,020 mg/kg) were above background levels.

Landfill 2: Low levels of pesticides, PCBs, SVOCs, and VOCs were detected. All were below reference criteria. Arsenic up to 20 mg/kg, chromium (up to 85 mg/kg), iron (up to 31,000 mg/kg), manganese (up to 605 mg/kg), and nickel (up to 34 mg/kg) were detected above reference criteria.

Landfills 3 and 4: Big Ledge Brook and the unnamed stream north of 3 and 4 did not contain constituents above reference criteria. Low levels of VOCs, pesticides, and SVOCs were detected in the sediments. The sediments of Sandy Brook contained substantial areas with iron, manganese, and arsenic above background levels and reference criteria. Concentrations of arsenic above 1,000 mg/kg were detected in the sediments of a groundwater seep adjacent to Sandy Brook. These sediments were excavated and removed as part of the NTCRA. Arsenic concentrations within Sandy Brook ranged up to 200 mg/kg.

Groundwater:

Approximately 10 groundwater sampling events have been performed as part of the RI/FS. Groundwater from 41 monitoring wells and several nearby residential wells was analyzed for a full range of contaminants (VOCs, SVOCs, PCBs, and TAL metals). The results of this sampling are summarized below.

Landfills 1and 2: The clay layer beneath this area provides a natural barrier that prevents leachate from impacting the groundwater in the deeper aquifer. However, leachate from Landfill 1 has contaminated a small area of shallow groundwater adjacent to the landfill. Groundwater impacted by Landfill 2 is contaminated with iron and manganese at concentrations above the reference criteria. Low levels of organics were also found during groundwater sampling; however, only benzene exceeded the reference criteria.

Landfills 3 and 4: Arsenic, benzene, iron and manganese have been consistently detected at concentrations above their reference criteria during groundwater sampling events. Whereas benzene contamination is limited to the bedrock aquifer, arsenic, iron, and manganese contamination are found in both the overburden and bedrock aquifer. The absence of a clay layer underneath Landfill Areas 3 and 4 has allowed these contaminants to migrate from the shallow to deep aquifer.

Residential wells: Residential drinking water wells in the vicinity of the site have not been impacted by groundwater contamination beneath the site. No VOCs, SVOCs were found in any of the wells while detected inorganic parameters were all well below reference criteria.

Chemical Plume Maps presented as Figure 8 illustrates the distribution of arsenic, iron, and manganese in the overburden aquifer based on the June 1998 data. Figure 9 shows the isopleths for arsenic in the bedrock aquifer based on the June 1998 data.

3. Fate and Transport of Contamination

Based on work completed during the RI and subsequent investigations completed by the USGS, a conceptual model for the occurrence of contamination in groundwater has been developed for the Site. Note that this discussion focuses on arsenic as it was identified to be the primary risk driver for the site. However, the discussion and conclusions can be applied to the other contaminants of concern as they will have fate and transport characteristics similar to arsenic.

Figure 10 shows a cross-section of the gravel pit, from the toe of the landfill to Sandy Brook. This figure shows the distribution of arsenic in both the overburden and bedrock aquifers based on June 1998 data from both RI/FS and USGS monitoring wells. Arsenic concentrations in the overburden aquifer are greatest in the MW-97-13 series wells and decreased by almost an order of magnitude to the MW-97-14 series wells located approximately 400 feet downgradient of the landfill. The observed decrease in concentration is attributed primarily to dilution through precipitation recharge to the aquifer. Groundwater bedrock contamination appears limited to the upper fractured portion of the rock. The strong upward gradients observed in these wells indicate groundwater flows from the rock to the overburden aquifer, with ultimate discharge to Sandy Brook.

<u>Occurrence of Arsenic in Groundwater</u>

Two distinct, yet dependent, processes govern the occurrence of arsenic in groundwater at the Site; the first is a biological process, and the second is a physical process (Colman and Lyford, 1999, Stollenwerk and Colman, 1998; Stollenwerk and Colman, 1999). The biological process is the consumption of oxygen by microbial organisms as they feed on the dissolved organic carbon (DOC) present in the system. The physical process is the reductive dissolution of arsenic and iron contained both within the aquifer materials and in the bedrock caused by the reducing conditions created by depletion of oxygen below the landfill. The USGS studies indicate that mobile arsenic (i.e., As (III)) is present in groundwater only when oxygen is absent.

The USGS studies further indicate that large quantities of DOC may be adsorbed to the grains of the aquifer materials downgradient of the landfill between Area 4 and Sandy Brook. Adsorption of DOC onto aquifer materials in significant quantities suggests that DOC may provide a long-term source of nutrients for the microbial population within this area. The long-term source of nutrients means that the microbial population will consume oxygen until the DOC or oxygen supply is exhausted. Once the DOC in the system has been consumed, the demand for oxygen by the microbes will begin to decrease. The purpose of the landfill cap is to cut-off infiltration of rainfall thereby preventing the formation of DOC-rich leachate. As the availability of DOC decreases, the ability of reducing conditions to be sustained will become less pronounced causing a corresponding decrease in the reductive dissolution of arsenic and iron from the coatings of the overburden aquifer materials and from the bedrock. Significant amounts of recharge to the groundwater system now occur only in areas not covered by the cap. The recharge entering the flow system above the landfill outside of the capped area will eventually introduce more oxygen-rich waters to the area beneath the landfill. Concentrations of iron, manganese, and arsenic in groundwater will decrease over time as fresh oxygenated water flushes through the system diluting the existing groundwater and pushing the equilibrium of the reductive dissolution/precipitation reaction toward the precipitation side of the equation. Eventually, oxygen-rich waters will serve to immobilize the arsenic by precipitating first iron, then manganese, and finally arsenic beneath the landfill.

The time frame for the stabilization of arsenic is uncertain and governed to a large extent by the DOC available to microorganisms. Laboratory core leaching studies and modeling projections by the USGS indicate that arsenic concentrations in groundwater will stabilize at or below concentrations of 50 µg/L after 30 to 50 pore volumes ("flushings") have been flushed through the system. Based on modeled travel time of approximately two years for groundwater flushings from the toe of Landfill Area 4 to reach the stream, arsenic concentrations will stabilize after approximately 60 to 100 years.

Mixing of Groundwater with Surface Water

Mixing of groundwater discharging from Landfill Area 4 with streamflow in Sandy Brook will result in lower chemical concentrations in surface water than in the discharging groundwater. The resulting concentrations will be a function of the concentrations in influent groundwater, the quantity of influent groundwater, the concentrations in influent surface water, and the quantity of surface water at the point of groundwater discharge. Calculations using stream discharges measured by the USGS indicate that groundwater discharge from the plume represents about five percent of total streamflow at high flow and about 39 percent of total streamflow at low flow (see Appendix B-3 of the FS). Consequently, at high flow, concentrations of inorganic chemicals in surface water downstream of the plume discharge should represent about five percent of the concentrations in the discharging groundwater. Details regarding the low-flow and high-flow scenarios and sensitivity of the scenarios is included in Appendix B of the FS.

When arsenic concentrations at the core of the plume have been reduced to 50 µg/L and the weighted-average groundwater concentration reduced to about 15 µg/L, arsenic concentrations in the stream are estimated to be at or below the practical quantitation limit (PQL) for arsenic of 3 µg/L at harmonic mean flow. Table 5 presents a summary of predicted arsenic concentrations in surface water 0 to 200 years after the landfill cap has been in place. Figure 11 presents the predicted arsenic concentrations in Sandy Brook at Annual Harmonic Mean Flow.

Uncertainty Assessment

The uncertainty associated with this model is based on the uncertainties associated with each component of the model. However, the conservative nature of many of the assumptions used in the developing the groundwater flux and surface water transport model, ensure that the arsenic concentrations predicted for Sandy Brook are conservative. Additionally, because the arsenic concentrations in Sandy Brook are most sensitive to the volume of flow within the brook, actual arsenic concentrations measured at any given time may vary depending on the actual flow volume. Based on USGS flow information, the harmonic mean of 0.35 cubic feet per second (i.e., approximately 1% of high flow conditions) is an appropriate estimate for predicting the average exposure point concentrations for arsenic in surface water. It is expected that this model will continue to be updated and evaluated during each 5-year site review conducted by USEPA. Until these future evaluations can be completed, the model is provided as a reasonable estimate of arsenic concentrations in Sandy Brook surface water over time (see Table 5 and Figure 11).

F. CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

The Site is bordered by wooded areas in all directions with the exception of a sand and gravel quarry southeast and adjacent to Area 4. The surrounding area is semi-rural, with residences located along Route 112 (northeast of the Site), along Louden Road (north of the Site), and along Route 5 (south and west of the Site). Land use is mixed, and includes primarily low-density residential, agricultural, light commercial, and forested areas.

Prior to 1975, all residences in the area were serviced by private wells. In 1975, the Biddeford and Saco Water Company extended water lines along Route 112 just south of Louden Road, and along a portion of Jenkins Road, south and east of the Site. Residences located west of Deep Brook along Route 5 and south of the Site are currently serviced by private wells. A preliminary residential well survey was conducted as part of the Fall 1995 Phase 1A RI and identified the nearest drinking water well downgradient of the Site on Fire Lane 10, within approximately one-half mile of the Site.

The Site is currently closed as a landfill facility. Landfill cover systems were placed over Landfill Areas 1 and 2 in 1976 and 1985, respectively. As part of the NTCRA, a RCRA Subtitle C cover system has been placed over Landfill Areas 3 and 4 as a source control measure, and institutional controls, including restrictions on future land and groundwater use have been implemented at the Site. Land and groundwater use has been restricted by the "Grant of Environmental Restrictions and Right of Access" (Environmental Restrictions) agreed to by the City, the EPA, and the MEDEP. These Environmental Restrictions are considered necessary to ensure long-term protection of public health. The Environmental Restrictions include:

- No use that disturbs the integrity of any layers of the cap, or any other structures for maintaining the effectiveness of the Removal Action, whether in place now or put in place in the future;

- No groundwater and surface water use, including, but not limited to, use as a drinking water supply. No groundwater wells shall be installed within the Groundwater Restriction Parcel except for purposes of groundwater monitoring pursuant to a plan approved by the City, EPA and MEDEP;

- No residential development and no activity or use at the Site which adversely impacts the Removal Action (NTCRA), whether now or in the future, including, without limitation: (1) systems and areas to collect and/or contain groundwater, surface water runoff, or leachate; (2) systems or containment areas to excavate, dewater, store, treat, and/or dispose of soils and sediments; and (3) systems and studies to provide long-term environmental monitoring of groundwater, surface waters, and to ensure the long-term effectiveness of the Removal Action and its protectiveness of human health and the environment.

These restrictions were developed as part of the NTCRA and can only be modified by written approval from the Maine Commissioner of Environmental Protection and the Director of EPA's Office of Site Remediation and Restoration.

Community and stakeholder input was sought and incorporated throughout the course of EPA-lead activities at the Site. Attempts to solicit views on the reasonably anticipated future land uses and potential future groundwater uses at the Site and adjacent areas were made through joint efforts between EPA, MEDEP, and the City by holding several public hearings with opportunities for formal public input on proposed Site activities. In addition, the City of Saco has developed an environmental restoration and recreational re-use plan for the Site area. This plan was developed by the City planning office and was developed with public input. The plan describes the restoration of the former borrow pit downgradient of Landfill Areas 3 and 4 into a wetland habitat and the possible use of land adjacent to landfill1 for recreational fields.

G. SUMMARY OF SITE RISKS

A baseline human health and ecological risk assessment was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The human health risk assessment (HHRA) followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and non-carcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the HHRA (Appendix F of the RI Report, Woodard & Curran, March 1998) that support the need for remedial action is discussed below followed by a summary of the ERA.

1. Human Health Risk Assessment

The HHRA performed an assessment of exposure to surface water, sediment, soil, and groundwater. Since only the groundwater had a risk outside of the acceptable risk range, it will be discussed. Fifty-two of the 69 chemicals detected in groundwater downgradient of Landfill Areas 3 and 4 were selected for evaluation in the HHRA as chemicals of potential concern (COPCs). The COPCs were selected to represent potential site-related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment and can be found in Table 4 and Table 9 of the HHRA Report. From the selection of groundwater COPCs, a subset of the chemicals were identified in the FS as presenting a significant current or future risk and are referred to as the chemicals of concern (COCs) in this ROD. The groundwater COCs are summarized in Table 6, which includes the detection frequency, range of detections, the exposure point, and exposure point concentrations (maximum detected concentrations) used to evaluate the reasonable maximum exposure (RME) scenario in the baseline risk assessment for the COCs. Estimates of average or central tendency exposure concentrations for the COCs and COPCs can be found in the 1998 RI and 2000 FS.

Exposure Assessment

Potential human health effects associated with exposure to the COPCs were estimated quantitatively or qualitatively through several hypothetical exposure pathways that were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the Site. Trespassers and persons accessing the Site for recreational activities were considered to represent the maximum potentially exposed population. Although there is some maintenance activity at the Site, these types of exposures were considered significantly less than possible trespasser exposure. In addition, the presence of wetlands and landfill wastes precludes residential development for the foreseeable future. The City has also placed institutional controls on the property to prohibit the future use of groundwater as a drinking water source.

Exposure by a trespasser to residual contamination at the Site is possible through several pathways. The exposure pathways that were evaluated under current and assumed future land uses are presented in Table 7. The exposure pathways that were selected for evaluation in the HHRA were direct contact with and incidental ingestion of chemicals in surface soil by a recreational user/trespasser; direct contact with and incidental ingestion of chemicals in sediment by a recreational user/trespasser; and ingestion of groundwater as residential drinking water.

A conservative estimate for exposure to surface water and sediments at the Site was assumed to occur via child trespassers/recreational users (ages 6-18, with an average weight of 42 kg) exposed to surface water and sediments through direct contact or incidental ingestion. The frequency of contact was assumed to be 20 days per year (twice per week for the 10 weeks of summer, best professional judgment) for 12-year exposure duration. It was assumed that the child ingests 50 milliliters (mL) of surface water and 100 milligrams (mg) sediment per exposure (MEDEP, 1994; EPA, 1991). It was further assumed that the child is in contact with 1,000 mg sediment per event (MEDEP, 1994; EPA, 1989), and that the surface area exposed to the water is one-half the total body surface area, or 5,240 cm^2 (MEDEP, 1994). Each exposure was assumed to be the maximum detected concentration of each COC.

Exposure to groundwater at Landfill Areas 3 and 4 were assumed to occur via residents (adults weighing 70 kg) exposed to groundwater through ingestion, dermal contact, and inhalation of volatiles. Residents were assumed to ingest 2 liters of water per day, 350 days per year, for a 30-year exposure duration (EPA, 1991). For volatile organic compounds (VOCs), inhalation and dermal exposures were evaluated by doubling the risk attributed to the ingestion pathway (EPA, 1991). Exposure via dermal contact (19,400 cm^2 skin surface area) to non-VOCs was assumed to occur 2.9 days per year, for a 30-year exposure duration (EPA, 1991, 1992). Each exposure was assumed to be to the maximum detected concentration of each COC.

A more thorough description of exposure pathways evaluated in the HHRA, including estimates for an average exposure scenario, can be found Section 4 of the HHRA (Woodard & Curran, March 1998).

Risk Characterization

Excess lifetime cancer risks were determined for each exposure pathway by multiplying a daily intake level with the chemical specific cancer potency factor. Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g., 1×10^{-6} for 1/1,000,000) and indicate (using this example) that an average individual is not likely to have greater that a one in a million chance of developing cancer over 70 years as a result of site-related exposure (as defined) to the compound at the stated concentration. All risks estimated represent an "excess lifetime cancer risk" - or the additional cancer risk on top of that which we all face from other causes such as cigarette smoke or exposure to ultraviolet radiation from the sun. The chance of an individual developing cancer from all other (non-site related) causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site related exposure is 10^{-4} to 10^{-6}. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances. A summary of the cancer toxicity data relevant to the groundwater COCs is presented in Table 8.

In assessing the potential for adverse effects other than cancer, a hazard quotient (HQ) is calculated by dividing the daily intake level by the reference dose (RfD) or other suitable benchmark. Reference doses have been developed by EPA and they represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. A HQ ≤ 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g. liver) within or across those media to which the same individual may reasonably be exposed. A HI ≤ 1 indicates that toxic noncarcinogenic effects are unlikely. A summary of the noncarcinogenic toxicity data relevant to the groundwater COCs is presented in Table 9.

Table 10 and Table 11 depict the carcinogenic and non-carcinogenic risk summaries for the COCs in Landfill Areas 3 and 4 groundwater that were evaluated to reflect present and potential future exposure from incidental ingestion and direct contact to trespassers/recreational users from corresponding to the reasonable maximum exposure (RME) scenario. Only those exposure pathways deemed relevant to the remedy being proposed are presented in this ROD. Readers are referred to Section 6 of the HHRA for a more comprehensive risk summary of exposure pathways evaluated for the COPCs and for estimates of the central tendency risk.

Uncertainty

Important sources of uncertainty in the hazard identification and exposure assessment of the HHRA included:

- Location and adequacy of the sampling plan;
- Selection of COCs;
- Assumptions regarding current and future land use (e.g., frequency, duration, and intensity);
- Assumptions regarding physiological factors (e.g., dermal absorption rates, inhalation rates); and
- Monitoring data to be used to estimate the EPC.

Important sources of uncertainty in the toxicity assessment included:

- Carcinogenic toxicity expressed in cancer slope factor, which reflect uncertainties in the extrapolation form high to low doses and extrapolating from animals to humans;
- Noncarcinogenic toxicity as expressed in Reference Doses, which reflect uncertainties in extrapolating to sensitive human populations, from animals to humans, and form shorter-term to longer-term studies;
- Limited toxicity information for site chemicals; and
- Unavailable toxicity values for site chemicals.

Summary of Human Health Risks

As a result of the low permeability cover system designed and constructed for Landfill Areas 3 and 4 between 1997 and 1998 as part of the NTCRA, contaminated surface soils and landfill waste material were covered by the landfill cap and are no longer considered a medium of concern. Exposure to sediments and surface water associated with a stream and a pool to the north of Landfill Areas 3 and 4, a pool south of Areas 3 and 4, Sandy Brook to the southeast of Areas 3 and 4, and Big Ledge Brook to the southwest of Areas 3 and 4 was quantitatively evaluated. The estimated carcinogenic risks and non-carcinogenic HIs were below EPA and MEDEP upperbound limits of acceptable risk for each sub-area of concern for a child trespasser scenario. The child trespasser scenario was used as a conservative estimate of potential risk. Therefore, potential exposure to these media does not pose an unacceptable risk.

For groundwater to the south-southeast of Landfill Areas 3 and 4, the estimated potential carcinogenic risk and non-carcinogenic HI based on exposure to groundwater exceeded the EPA and MEDEP upperbound limits of acceptable risk. The compound contributing most significantly to carcinogenic risk was arsenic (detected at a maximum of 566 μg/L and contributing 99.8% of the risk). The compounds contributing most significantly to the non-carcinogenic HI were also arsenic (contributing 50.8% of the HI risk) and manganese (detected at 43,200 μg/L and contributing to 48.5% of the HI risk). The maximum concentrations of eight chemicals (benzene, trichloroethene, aluminum, arsenic, lead, manganese, nickel, and thallium) detected in wells southeast of Landfill Areas 3 and 4 met or exceeded the MCLs or MEGs for drinking water. Based on this assessment, groundwater in the area is not suitable as a drinking water source.

2. Ecological Risk Assessment

An Ecological Risk Assessment (ERA) was completed for the Site to evaluate the likelihood and magnitude of potential ecological effects associated with the discharge of Site groundwater to Sandy Brook. During the RI, comprehensive, site-wide sampling was conducted of site soils, groundwater, surface water, and sediment. Partly in response to this sampling, Landfill Areas 3 and 4 were capped in 1997, and contaminated sediments associated with a groundwater seep to Sandy Brook were removed and the seep filled in. As the result of these two actions, the only exposure pathway for ecological receptors that was identified was the discharge of groundwater from Area 4 of the landfill to the surface waters of Sandy Brook south of Area 4 and the resulting sediment contamination. This potential exposure pathway area was focus of the ERA.

The final version of the ERA was a summary and compilation of over two years of ecological investigations. The ERA incorporated results of several investigations, initiated through discussions with EPA, MEDEP, the U.S. Fish and Wildlife Service, and the City, which reflected a phased approach to identifying and quantifying potential ecological effects at the Site. Contaminated sediment was remediated (by removal) twice during the course of the ERA investigations. Conclusions of the ERA were based on data collected after the first, and largest, sediment remediation in December 1996-January 1997.

<u>Identification of Chemicals of Potential Concern (COPCs)</u>

For the ecological screening, maximum concentrations of contaminants detected in surface water and sediments during the RI were compared to established numerical benchmarks to identify contaminants that exceeded these benchmarks and warranted further evaluation. As described in detail in Section 2 of the ERA (Woodard & Curran, February 2000), arsenic and site-related iron and manganese all exceeded a benchmark standard in sediment to provide a conservative estimate of potential risk. Arsenic is the most toxic of these three and was selected as the primary COPC. Compounds with maximum concentrations that fell below relevant benchmark concentrations were assumed not to present a significant ecological risk and were not evaluated further. Only surface water and sediment data were evaluated in this manner, because these are the only media affected by recharge of Sandy Brook from Area 4 groundwater. Installation of a cap on Area 4 prevents direct contact with potentially contaminated material within the landfill areas, and eliminated the need to address exposure from on-site soils to terrestrial biota.

A review of arsenic toxicology showed that arsenic does not biomagnify in aquatic or terrestrial food chains since organisms at higher trophic levels that are exposed to this metal rapidly detoxify it and eliminate it from their system. While arsenic can occur in relatively high levels in the tissues of aquatic biota, most of it (approximately 70%) is in organic forms. This suggests that species at higher trophic levels in the aquatic food chain, as well as terrestrial organisms that might be exposed through incidental or accidental ingestion of arsenic are unlikely to experience adverse effects. However, arsenic does bioaccumulate in aquatic organisms. In the aquatic environment, if factors that reduce arsenic bioavailability are low (e.g., low concentration of sulfides, organic carbon, and iron oxides), then effects on aquatic organisms may occur and changes in population or community structure of aquatic organisms are possible and measurable.

The range of detected arsenic concentrations in surface waters and sediments, the frequency of detection, mean concentrations, upper confidence limits, and benchmark standards for arsenic in surface water and sediments are indicated in Table 12 and Table 13.

<u>Exposure Assessment</u>

In order to understand potential exposure pathways and receptors associated with the recharge of Sandy Brook by Area 4 groundwater, the habitat in and around Sandy Brook was evaluated by a site walkover conducted by a field biologist with Exponent, Inc. in February 1998. The purpose of the site walkover was to describe the type and extent of habitat that exist on and adjacent to the Site. Although site-related contaminants are primarily transported through groundwater to Sandy Brook south of Area 4, the habitat characterization focuses on the majority of the length of Sandy Brook in order to identify potential off-site exposure pathways and sensitive habitats where the potential exposure to chemicals may be of concern. Rare, threatened, or endangered species were not observed during the habitat assessment, and have not been recorded in the area. Overall, the quality of the freshwater systems and associated forests in and around Sandy Brook is good. The presence of habitat that is unimpacted by off-site sources and is suitable for typical riverine species ensures that an accurate and realistic exposure assessment can be conducted for biological populations at the Site.

Concentrations of dissolved arsenic in Sandy Brook, while biologically available, were shown to be below EPA Ambient Water Quality Criteria (AWQCs), a conservative estimate of the potential risk to aquatic biota. Surface water was not considered an exposure medium of concern since surface water concentrations were below the AWQC ecological benchmark value (Table 12).

Potential receptors identified in the ERA were those organisms exposed to sediments through either dermal contact or ingestion, and included benthic macroinvertebrates, fish, and herptiles. Benthic macroinvertebrates, which spend all or nearly all of their lifespans in or near the sediment, were identified as the primary receptors at the Site and assessment endpoints since they are immobile, abundant, in direct contact with, and ingesting sediment at the Site (Table 14).

Ecological Exposure Pathways of Concern
Table 14

Exposure Medium	Sensitive Environment Flag Y or N	Receptor	Endangered /Threatened Species Flag Y or N	**Exposure Routes**	Assessment Endpoints	Measurement Endpoints
Sediment	Y	Benthic organisms	N	Ingestion, respiration, and direct contact with chemicals in sediment	Benthic invertebrate community species diversity and abundance	Toxicity of soil to *Hyallela azteca* Species diversity index

<u>Ecological Effects Assessment and Risk Characterization</u>

In the ERA, risks to benthic invertebrates were evaluated qualitatively by benthic surveys and quantitatively by acute and chronic toxicity tests. To identify the community-level effects of sediment arsenic on benthic populations, a macroinvertebrate survey was conducted. This survey found slight to moderate impairment of the benthic community south of the remediated seep area in Sandy Brook. To determine the toxicity effects of stream sediments, and to evaluate whether community-level effects observed in the risk-based population resulted specifically from arsenic, acute and chronic toxicity tests were conducted using whole sediments collected from Sandy Brook. Separate line-of-evidence tests were conducted to determine sediment effects on survival, growth, and reproduction of the sensitive amphipod Hyalella azteca under conditions of acute and chronic exposure. These toxicity tests showed that stream sediments had little effect on survival, but reduced levels or organism growth and reproduction. The line-of-evidence evaluation of toxicity data suggests that moderate reduction in growth and reproduction may occur with sediment arsenic concentrations greater than 106 mg/kg. Subsequent to toxicity testing, comprehensive sediment sampling of 2,200 feet of Sandy Brook at and downstream of the area potentially affected by Area 4 groundwater to quantify the actual range of exposure currently occurring at Sandy Brook. This sampling reflected sediment conditions after the first and largest, removal of sediment in December 1996 through January 1997. This evaluation showed that only a small percentage of the stream had arsenic concentrations sufficient to adversely affect reproduction of a sensitive benthic species. Discharge of groundwater from Area 4 has had a measurable impact on the benthic macroinvertebrate community of Sandy Brook. Although post-remediation concentrations of site-related contaminants are lower than they were before remedial activities, they may still present risks of minor adverse effects among sensitive members of the benthic community. The potential for impacts from current levels of site-related contaminants are limited to a small portion of the brook downstream of the remediated seep. Observed effects do not constitute a significant impact on the ecology of Sandy Brook and do not warrant additional remediation of Area 4 sediments of Sandy Brook. A full description of the ecological risk characterization for the Site is available in Section 4 of the ERA (Woodard & Curran and Exponent, 2000).

<u>Uncertainty</u>

The major sources of uncertainty related to the Saco Landfill ERA are:

- Representativeness of sampling locations;
- Representativeness of sampling frequency;
- Selection of arsenic, iron, and manganese as substances of concern;
- Selection of benthic macroinvertebrates as key ecological receptors;
- Representativeness of toxicity test of one species;
- Representativeness of benthic community assessment;
- Accuracy of the weight-of-evidence approach;
- Protectiveness of sediment quality values;
- Population level of uncertainty; and uncertainty in risk characterization.

Conservative assumptions were made throughout the risk assessment to ensure that the ecological receptors are sufficiently protected. Therefore, when all of the assumptions are combined, it is much more likely that risks are overestimated rather than underestimated. A complete discussion of the evaluation of uncertainty for the Site is available in Section 5 of the ERA.

3. Basis for Response Action

Because the baseline HHRA revealed that, if future residents were to use the groundwater as a long-term water supply it would present an unacceptable human health risk (e.g., groundwater concentrations of COCs exceed EPA and MEDEP drinking water standards), actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Additionally, the Ecological Risk Assessment identified a minimal ecological risk to benthic organisms which will be addressed through alternatives addressing groundwater.

H. REMEDIATION OBJECTIVES

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, response action objectives (RAOs) were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to human health and the environment. The RAOs for the selected remedy for OU1 are:

- Prevent the ingestion of groundwater containing contaminants that exceed Federal or State maximum contaminant levels (MCLs), non-zero maximum contaminant level goals (MCLGs), maximum exposure guidelines (MEGs), or in their absence, an excess cancer risk of 1×10^{-6} (one in a million) or a hazard quotient of 1;

- Restore groundwater to meet Federal or State MCLs, MCLGs, MEGs, or in their absence, an excess cancer risk of 1×10^{-6} (one in a million) or a hazard quotient of 1; and

- Perform long-term monitoring of surface water, sediments, and groundwater to verify that the cleanup programs at the Site are protective to human health and the environment.

A complete description of the RAOs is presented in Section 3 of the FS.

I. DEVELOPMENT AND SCREENING OF ALTERNATIVES

1. Statutory Requirements/ Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that EPA's remedial action, when complete, must comply with all Federal and more stringent State environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these Congressional mandates.

2. Technology and Alternative Development and Screening

CERCLA and the National Contingency Plan (NCP) set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives was developed for the Site.

With respect to source control, the RI/FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long-term management. This range also included alternatives that treat the principal threats posed by the site but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternative(s) that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative. The source control component for the Site, removal of contaminated sediments from Sandy Brook and capping of surface soils in Landfill Areas 3 and 4 was addressed as part of the NTCRA conducted between 1997 and 1998 and therefore is not included explicitly as part of remedial alternative evaluation for this ROD.

With respect to groundwater response action, the RI/FS developed a limited number of remedial alternatives that attain site-specific remediation levels within different time frames using different technologies; and a no action alternative. As discussed in Section 5 of the FS, groundwater treatment technology options were identified, assessed, and screened based on implementability, effectiveness, and cost. Section 6 of the FS presented the remedial alternatives developed by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e)(3) of the NCP. The purpose of the initial screening was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. Each alternative was then evaluated in detail in Section 7 of the FS.

In summary, of the five remedial alternatives screened in Section 5, four were retained as possible options for the cleanup of the Site. From this initial screening, four alternatives were selected for detailed analysis.

J. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each remediation alternative evaluated.

1. Source Control Alternatives Analyzed

Source control measures were previously addressed at Landfill Areas 3 and 4 as part of the NTCRA.

2. Management of Migration Alternatives Analyzed

Management of migration (MM) alternatives addresses contaminants that have migrated into and with the groundwater from the original source of contamination. At the Site, contaminants have migrated into groundwater beneath and down-gradient of Landfill Areas 3 and 4 and into down-gradient surface waters and sediments of Sandy Brook. The four MM alternatives proposed for the Site include:

SML-1, No Further Action: This alternative would not include additional work or costs beyond the early cleanup. EPA would leave the site as it is, and no efforts would be made to control the migration of the contaminants in groundwater or to restore the aquifer.

Capital Costs: none
Present Worth of Long-Term Monitoring: 0

SML-3, Monitored Natural Attenuation: This alternative would rely upon natural degradation and dilution processes to cause the levels of contamination to drop below the cleanup levels specified in this ROD. No active control over the migration of groundwater would occur during the 60-100 years needed for the groundwater to reach cleanup levels. Contaminated groundwater would continue to discharge into Sandy Brook during this time period. However, contaminant concentrations are expected to decrease with time.

Long-term monitoring would be performed to detect any change in concentrations of contaminants in the groundwater and surface water. Sediment monitoring would also be performed to ensure that contaminant levels are not adversely impacting aquatic and/or terrestrial organisms.

Five-year reviews would be performed by EPA to assess Site conditions and determine if the cleanup approach is protective of public health and the environment. If the substantial progress in reducing concentrations is not demonstrated within 10 years, a re-evaluation of the clean-up action will be performed.

Capital Costs: none (some costs may be incurred if additional monitoring wells are necessary)
Present Worth of Long-Term Monitoring: $1.7 million

SML-4, In-situ Chemical Oxidation with Groundwater Extraction with On-site Treatment: This alternative would actively treat the chemical source of groundwater contamination by using chemical reagents to destroy the reservoir of organic carbon present in the subsurface soil and bedrock fractures. This innovative technology, if effective, would dramatically reduce the time period required for the groundwater and surface water to reach the cleanup goals. As part of this cleanup option, a groundwater extraction and treatment system would be installed to control the migration of contaminated groundwater and to prevent the migration of the chemical reagents into the surface water. The extracted groundwater would be treated and then discharged to either the City of Saco sewer system or into the on-site infiltration gallery. This discharge location will determine the treatment standards. It is anticipated that federal drinking water standards and state Maximum Exposure Guidelines would be the treatment standards if re-infiltration is the discharge option.

This alternative would:(1) install a long-term groundwater extraction and treatment system to reduce the contaminant contribution to Sandy Brook and provide control over the release of the chemical reagents; (2) inject chemical reagents to reduce the available organic carbon in the aquifer and to immobilize the metals contaminants; and (3) perform long-term monitoring of surface water groundwater and sediments.

If the chemical reagents are successful, then compliance with the cleanup levels could be met in 5-10 years. If the chemical reagents are unsuccessful, then the cleanup should be met in 40-75 years.

One serious concern is that any extraction system that is installed to intercept the contaminated groundwater will draw groundwater from Sandy Brook, reducing its flow, thereby, resulting in negative impacts on the environment.

Five year reviews would be performed to assess the Site conditions and determine if the cleanup approach is protective of public health and the environment.

Capital Costs: $1.4 million
Present Worth (includes maintenance, monitoring, periodic reviews): $5.7 million

SML-5, Groundwater Extraction with On-site Treatment: This alternative would actively control the migration of contaminated groundwater by extracting the groundwater before it moves off-site. The extracted groundwater would be treated, as necessary prior to discharge to either the City of Saco sewer system or into an on-site infiltration gallery. It is anticipated that federal drinking water standards and state Maximum Exposure Guidelines would be the treatment standards if re-infiltration is the discharge option. This approach is expected to result in groundwater restoration in 40-75 years. There should be some significant improvement in water quality given the reduction in contaminant flow. However, it is unlikely that an extraction system can be designed that will intercept 100% of the contaminated water discharging into Sandy Brook. Therefore, it is possible that the State Water Quality Criteria will be exceeded until groundwater cleanup levels are met. Also, one serious concern is that any extraction system that is installed to intercept the contaminated groundwater reducing its flow to Sandy Brook, thereby, resulting in negative impacts on the environment.

This alternative would: (1) install a long-term groundwater extraction and treatment system to reduce the contaminant contribution to Sandy Brook. The extraction system would be operated at an extraction rate that is designed to reduce the time period required to achieve cleanup levels and; (2) perform long-term monitoring of surface water groundwater and sediments.

Five year reviews would be performed to assess the Site conditions and determine if the cleanup approach is protective of public health and the environment.

Capital Costs: $1.1 million
Present Worth (includes maintenance, monitoring, periodic reviews): $3.3 million

Each of these MM alternatives is further detailed in Section 7 of the FS Report.

K. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that at a minimum EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a Site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are summarized as follows:

Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP:

1. **Overall protection of human health and the environment addresses** whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

2. **Compliance with applicable or relevant and appropriate requirements (ARARs)** addresses whether or not a remedy will meet all Federal environmental and more stringent State environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria:

3. **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4. **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.

5. **Short-term effectiveness addresses** the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. **Cost** includes estimated capital and Operation Maintenance (O&M) costs, as well a present-worth costs.

Modifying Criteria

The modifying criteria are used as the final evaluation of remedial alternatives, generally after USEPA has received public comment on the RI/FS and Proposed Plan:

8. **State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

9. **Community acceptance** addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. A comparative analysis of the threshold criteria and balancing criteria can be found in Table 8-1 of the FS, and included in this ROD as Table 15.

The sections below present the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis. Only those alternatives that satisfied the first two threshold criteria were balanced and modified using the remaining seven criteria.

<u>Overall Protection of Human Health and the Environment</u>

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

SML-1 is not protective as it does not identify the groundwater as being unacceptable for consumption and does not include cleanup levels as a benchmark for the evaluation of the success of the cleanup. Additionally, unlike the other alternatives, SML-1 does not include 5-year reviews. Alternatives SML-4 and SML-5 could potentially be more protective than SML-3 as both alternatives would contain a majority of the contaminant plume, thereby reducing the contaminant load to aquatic receptors in Sandy Brook more quickly than SML-3. However, it must be recognized that there is extremely low potential for exposure to contaminated groundwater and surface water due to the presence of institutional controls that will prohibit use of both water sources. Therefore, Alternatives SML-3, SML-4, and SML-5 are all considered to be equally protective of human health and the environment because clean-up goals will be met.

<u>Compliance with Applicable or Relevant and Appropriate Requirements</u>

Section 121 (d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA 121 (d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address hazardous substances, the remedial action to be implemented at the site, the location of the site or other circumstances present at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law which, while not applicable to the hazardous materials found at the site, the remedial action itself, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site.

Currently, arsenic and benzene exceed chemical-specific ARARS (i.e., MCLs) in groundwater. Arsenic and manganese exceed the State SWQC. Concentrations of arsenic, manganese, and benzene in groundwater are expected to be reduced to their respective PRGs within the same time frame for SML-1, SML-3, and SML-5. If proven effective, SML-4 (chemical oxidation with hydraulic containment) may reach PRGs in groundwater faster than the other alternatives.

Alternative SML-1 does not meet chemical specific ARARs. Neither location-specific nor action-specific ARARs apply to Alternative SML-1 , because no active remedial activities would be conducted. Alternative SML-3 would meet all chemical specific, location-specific, and action-specific ARARs. Alternatives SML-4 and SML-5 would meet chemical-specific, location-specific and action-specific ARARs.

Alternatives SML-3, SML-4, and SML-5 would comply with ARARs.

Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of the remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

For each of the alternatives except Alternative SML-1, remedial action objectives would be met over time. Alternatives SML-4 and SML-5, in regards to surface water quality, would not improve the long-term effectiveness over that provided by SML-3, because extraction of groundwater would not capture the entire plume, thereby allowing some arsenic contaminated groundwater to continue to enter Sandy Brook. SML-3, SML-4, and SML-5 include monitoring and five-year reviews and would be more effective than SML-1 because they provide a mechanism for evaluating future protectiveness of the alternative.

Five-year reviews would be necessary to evaluate the protectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above health-based levels.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternative SML-4 would involve the use of chemicals that would result in changes to the aquifer that would reduce the mobility of contaminants in the groundwater. Both SML-4 and SML-5 would include groundwater extraction and treatment systems that would reduce the volume of contaminants in the groundwater through capture of the contamination by the treatment system. SML-1 and SML-3 do not include a component which treats the contaminants.

Short-Term Effectiveness

Short-term effectiveness addresses a period of time needed to implement the remedy and any adverse impacts that may be posed to workers and the community during construction and operation of the remedy until cleanup goals are achieved.

Under Alternative SML-1, no remedial actions would be implemented; therefore, there would be no adverse effects on the local community or environments. Impacts to community and site workers and safety during environmental monitoring would be unlikely under Alternative SML-3, and no adverse impacts to the environment would be expected for this alternative. Alternative SML-4, chemical oxidation with hydraulic containment, would have increased short-term effectiveness over other alternatives by permanently reducing the leaching potential of contaminants in the aquifer, and containment of the plume by extraction could accelerate the reduction of surface water concentrations. It is expected that the groundwater PRG could be met in 30 years with Alternative SML-4; as compared to a minimum of 60 years with the other three alternatives. However, treatability studies would be required to determine the effectiveness of chemical oxidants. Furthermore, groundwater extraction required for Alternatives SML-4 and SML-5 could significantly impact surface water flow in Sandy Brook during periods of low flow. Under Alternative SML-5, construction of the groundwater discharge piping system to the Saco Waste Water Treatment Plant would impact the local community, although residents are not expected to be exposed to any site-related contaminants during construction or implementation of this remedy. Construction and operation of an on-site treatment system with Alternative SML-5 is not expected to impact local residents or the environments.

Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other government entities are also considered.

Alternative SML-1, no further action, would not require any implementation. All other treatment technologies are well developed and readily implemented. Alternative SML-4 would require significant and frequent maintenance of extraction wells due to fouling from the high concentrations of dissolved iron and other metals present in the plume.

Cost

The estimated present worth costs for the alternatives, not including the no action alternative, range from \$1.7 million for Alternative SML-3 to \$5.7 million for SML-4. Costs to implement Alternative SML-4 would be \$5.7M and costs to implement Alternative SML-5 would be \$3.3M compared to \$0 for Alternative SML-1 or \$1.7M for Alternative SML-3. The costs of the alternative vary according the type of treatment technology required to implement the remedy.

State Support/Agency Acceptance

The State expressed its support for Alternative SML-3 at the public hearing held on August 16, 2000, although the State's concurrence with the Proposed Plan included several contingent conditions. A copy of the concurrence letter is included as Appendix A of this ROD.

Community Acceptance

During the public comment period, the community expressed its support for Alternatives. However, one citizen did express a preference for alternative SML-4, chemical oxidation with hydraulic containment, over SML-3.

L. THE SELECTED REMEDY

1. Summary of the Rationale for the Selected Remedy

The selected remedy, Alternative SML-3, utilizes monitored natural attenuation of groundwater; long-term surface water and sediment monitoring and evaluation; and institutional controls to address the principal site risks. The source control component of the remedial alternative has already been addressed at the Site as part of the NTCRA.

The **major** components of the remaining selected remedy include:

- Monitoring of groundwater, surface water, and sediments to demonstrate that natural attenuation is protective;
- Establishment of an evaluation program to measure the progress of natural attenuation toward achieving the cleanup goals; and
- Institutional Controls

A detailed description of the remedial components of the selected remedy is provided in subsequent sections of this ROD and in Table 16.

2. Description of Remedial Components

Specific components of Alternative SML-3 include:

- Implementation of semi-annual monitoring of groundwater, surface water, and sediment. The program will continue at least until the first comprehensive review of the cleanup program (i.e., the 5-year review) to evaluate the effectiveness of the implemented plan, and may be adjusted upon assessment of remediation progress.
- Tracking the progress of natural attenuation by comparing data collected as part of the monitoring program with criteria that will be established to measure the effectiveness of the natural attenuation remedy.
- Monitoring stream sediments to verify that contaminant concentrations do not exceed levels considered to be safe to aquatic organisms. EPA will re-evaluate the potential environmental impacts of Site contamination if individual sample locations reveal arsenic levels above 200 mg/kg in isolated locations, or a more extensive area if arsenic levels are above 100 mg/kg.
- Monitoring surface water to evaluate compliance with surface water quality criteria (SWQC). A background study may also be performed to determine the naturally occurring levels of iron, manganese, and arsenic. Surface water monitoring will also be used to evaluate the trend in surface water quality in the area of Sandy Brook that exceeds SWQC.

Specific components of the natural attenuation evaluation program include:

- Evaluation of Site condition as part of each 5-year review to determine if the remedial action is protective of public health and the environment.
- Re-evaluation of the natural attenuation remediation approach, if, after the second 5-year review (10

years after the official start date of the long-term cleanup) an acceptable amount of contamination reduction in groundwater and surface water has not been demonstrated by the monitoring data. This re-evaluation will primarily be based upon the data collected as part of the long-term monitoring program. The re-evaluation will also evaluate the degree of compliance with SWQC over the previous 10 years, as well as any trends in sediment concentrations.

- Preparation of a report to describe the performance of the natural attenuation remedy. If the natural attenuation remedy does not meet the expectations established for the first 10 years of performance, then a subsequent report would be prepared to identify the shortcomings of the long-term cleanup plan to meet the established goals. The report would include, at a minimum, an evaluation of; (1) site conditions since the signing of the ROD, (2) the degree to which natural attenuation is still a viable option to achieve cleanup levels, and (3) other cleanup approaches that would meet the cleanup levels.

Specific components of the institutional controls/land use restrictions to be implemented at the Site include:

- A deed restriction entitled "A Grant of Environmental Restriction and Right of Access" has been implemented by the City and is included in Appendix G of the Final FS Report (Woodard & Curran, 2000b). This land use restriction will prohibit the disturbance of the landfill caps at the Site and prevent future groundwater use within and in proximity to areas of groundwater contamination. The deed restriction will also limit groundwater use in areas where the pumping of groundwater could cause the contamination to migrate. Finally, the deed restriction will prevent any use of the landfills that will degrade the protective cover systems. The areas where no future use of groundwater will be permitted as well as the area of limited groundwater use are shown in Figure 12.

If the selected remedy changes as a result of the remedial design and construction processes, then changes to the remedy described in this ROD will be documented in a technical memorandum in the Administrative Record for the Site, an Explanation of Significant Differences, or a ROD Amendment, as appropriate.

3. Summary of the Estimated Remedy Costs

The information in the cost estimate summary table for SML-3 (see Table 17) is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

4. Expected Outcomes of the Selected Remedy

The primary expected outcome of the selected remedy is that groundwater will meet the cleanup levels specified in this ROD at and beyond the point of compliance. Risk to human health from potential ingestion of groundwater will be addressed in the short term through institutional controls that prevent the consumption of groundwater during the time period required for natural attenuation processes to cause the level of contamination to drop below the proposed cleanup levels. Approximately 60 to 100 years are estimated as the amount of time necessary to achieve the cleanup goals established in this ROD. The selected remedy will also provide environmental and ecological benefits such as protection of sensitive benthic organisms living in contaminated stream sediments.

a. Cleanup Levels--Interim Groundwater Cleanup Levels

1. Interim cleanup levels have been established in groundwater for all chemicals of concern identified in the Baseline Risk Assessment found to pose an unacceptable risk to either public health or the environment. Interim cleanup levels have been set based on the ARARs (e.g., MCLs and more stringent State groundwater remediation standards) as available, or other suitable criteria described below. Periodic assessments of the protection afforded by remedial actions will be made as the remedy is being implemented and at the completion of the remedial action. At the time that Interim Ground Water Cleanup Levels and ARARs identified in the ROD and newly promulgated ARARs and modified ARARs which call into question the protectiveness of the remedy have been achieved and have not been exceeded for a period of three consecutive years, a risk assessment shall be performed on all residual groundwater contamination to determine whether the remedial action is protective. This risk assessment of the residual ground water contamination shall follow EPA procedures and will assess the cumulative carcinogenic and non-carcinogenic risks posed by all chemicals of concern (including but not limited to the chemicals of concern) via ingestion of groundwater and inhalation of VOCs from domestic water usage. If, after review of the risk assessment, the remedial action is not determined to be protective by EPA, the remedial action shall continue until either protective levels are achieved, and are not exceeded for a period of three consecutive years, or until the remedy is otherwise deemed protective or is modified. These protective residual levels shall constitute the final cleanup levels for this ROD and shall be considered performance standards for this remedial action.

   Because the aquifer under the Site is a potential drinking water source, MCLs, non-zero MCLGs established under the Safe Drinking Water Act, and State of Maine maximum exposure guidelines (MEGs) are ARARs.

   Interim cleanup levels for known, probable, and possible carcinogenic chemicals of concern (Classes A, B, and C) have been established to protect against potential carcinogenic effects and to conform with ARARs. Since MCLGs for Class A and B compounds are set at zero and are thus not suitable for use as interim cleanup levels, MCLs have been selected as the interim cleanup levels for these chemicals of concern. MCLGs for the Class C compounds are greater than zero, and can readily be confirmed; thus MCLGs have been selected as the interim cleanup levels for Class C chemicals of concern.

   Interim cleanup levels for Class D and E chemicals of concern (not classified, and no evidence of carcinogenicity) have been established to protect against potential non-carcinogenic effects and to conform with ARARs. Because the MCLGs for these Classes are greater than zero and can be readily confirmed, MCLGs and proposed MCLGs have been selected as the interim cleanup levels for these classes of chemicals of concern.

   Where a promulgated State standard is more stringent than values established under the Safe Drinking Water Act, the State standard was used as the interim cleanup level. In the absence of an

MCLG, an MCL, a proposed MCLG, proposed MCL, a more stringent State standard, or other suitable criteria to be considered (e.g., health advisory, state guideline), an interim cleanup level was derived for each chemical of concern having carcinogenic potential (Classes A, B, and C compounds) based on a 10^{-6} excess cancer risk level per compound considering the current or future ingestion of groundwater from domestic water usage. In the absence of the above standards and criteria, interim cleanup levels for all other chemicals of concern (Classes D and E) were established based on a level that represent an acceptable exposure level to which the human population including sensitive subgroups may be exposed without adverse affect during a lifetime or part of a lifetime, incorporating an adequate margin of safety (hazard quotient = 1) considering the current or future ingestion of groundwater from domestic water usage.

The table below summarizes the Interim Cleanup Levels for carcinogenic and non-carcinogenic chemicals of concern identified in groundwater. While the maximum concentrations of trichloroethene, aluminum, lead, nickel, and thallium exceeded MCLs an/or MEGs, the frequency of detection for these contaminants did not warrant the identification of specific cleanup levels. However, as described below, the selected remedy is expected to meet all ARARs (including MCLs and MEGs).

Interim Groundwater Cleanup Levels
Table 18

Carcinogenic Chemicals of Concern	Cancer Classification	Interim Cleanup Level (ug/l)	Basis	RME Risk
arsenic	A	50	MCL	8.8E-04
benzene	A	5	MCL	1.8E-06
Sum of Carcinogenic Risk				**8.8E-04**

Non-Carcinogenic Chemicals of Concern	Target Endpoint	Interim Cleanup Level (ug/l)	Basis	RME Hazard Quotient
arsenic	skin/ vascular system	50	MCL	4.6E+00
benzene	N/A	5	MCL	4.6E-02
manganese	central nervous system	200	MEG	2.3E-01
Sum of Hazard Index				**4.6E+00**

Key MCL: Federal Safe Drinking Water Act Maximum Contaminant Level MCLG: Federal Safe Drinking Water Act Maximum Contaminant Level Goal MEG: State of Maine Maximum Exposure Guidelines HI: Hazard Index RME: Reasonable Maximum Exposure Note: (1) USEPA has announced a proposal for a new drinking water standard for arsenic. The proposed standard is 5μg/L. (2) No MCL for Manganese exists; the 1992 Maine Maximum Exposure Guideline (MEG) is used.

All Interim Groundwater Cleanup Levels identified in the ROD, ARARs, and newly promulgated ARARs and modified ARARs which call into question the protectiveness of the remedy and the protective levels determined as a consequence of the risk assessment of residual contamination must be met at the completion of the remedial action at the points of compliance. At this Site, Interim Cleanup Levels must be met throughout the contaminated groundwater plume up to the edge of the waste management unit which includes the NTCRA components (landfill cap and retention basin). These values represent concentration levels that cannot be exceeded in any given well outside of the NTCRA components at the Site.

EPA has estimated that approximately 60 to 100 years will be required for groundwater to achieve the proposed cleanup goals, and cleanup goals will be considered to be achieved when the concentrations of the chemicals of concern have met the cleanup levels for a minimum of three years.

The cleanup levels for surface water shall be Federal and State water quality criteria. Groundwater contamination was identified as the primary aspect of the Site that must be addressed by the selected remedy; however, monitoring of the sediments is considered a necessary component of any cleanup action based on the presence of elevated levels of arsenic in the sediment.

The expected decrease in arsenic concentration in groundwater will result in further reduction in arsenic concentrations in surface water and sediments.

M. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Site is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, will comply with ARARs, and is cost effective. In addition, the selected remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable, and satisfies the statutory preference for treatment that permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element (see Table 19).

1. <u>The Selected Remedy is Protective of Human Health and the Environment</u>

The remedy at this Site will adequately protect human health and the environment by eliminating, reducing, or controlling exposures to human and environmental receptors. More specifically the Selected Remedy consists of monitored natural attenuation of groundwater beneath and downgradient of Landfill Areas 3 and 4; institutional controls, including land and groundwater use restrictions; and long-term groundwater and surface water monitoring in Sandy Brook.

The selected remedy will reduce potential human health risk levels such that they do not exceed EPA's acceptable risk range of 10^{-4} to 10^{-6} for incremental carcinogenic risk and such that the non-carcinogenic hazard is below a level of concern. It will reduce potential human health risk levels to protective ARARs levels (i.e., the remedy will comply with ARARs and TBC criteria). The selected remedy will reduce potential ecological risks by reducing concentrations of arsenic, iron, and manganese in site groundwater, thereby allowing surface water to meet SWQC. Additionally, the selected remedy will reduce the loading of arsenic, manganese and iron to the sediments, thereby preventing further impacts to stream biota. Implementation of the selected remedy will not pose any unacceptable short-term risks or cause any cross-media impacts.

At the time that ARARs identified in the ROD and newly promulgated ARARs and modified ARARs that call into question the protectiveness of the remedy have been achieved and have not been exceeded for a period of three consecutive years, a risk assessment shall be performed on the residual groundwater contamination to determine whether the remedy is protective. This risk assessment of the residual groundwater contamination shall follow EPA procedures and will assess the cumulative carcinogenic and non-carcinogenic risks posed by residential ingestion of groundwater. If, after review of the risk assessment, the remedy is not determined to be protective by EPA, the remedial action shall continue until protective levels are achieved and have not been exceeded for a period of three consecutive years, or until the remedy is otherwise deemed protective. These protective residual levels shall constitute the final cleanup levels for this ROD and shall be considered performance standards for any remedial action.

2. <u>The Selected Remedy Complies With ARARs</u>

The selected remedy will comply with all Federal and any more stringent State ARARs that pertain to the Site. A discussion of the requirements that are applicable or relevant and appropriate to the Selected Remedy is discussed in detail in Section 3.2 of the FS Report. Furthermore, tables of Federal and State ARARS and TBCs for the Site are included in Appendix D of this ROD.

In particular, the remedy will comply with the following Federal ARARS:

<u>Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs), 40 CFR 141.11 - 141.16.</u> The SDWA MCLs are relevant and appropriate because they are the basis for some of the interim cleanup levels (<u>i.e.</u>, the Interim Ground Water Cleanup Levels) for the Site groundwater, which is a potential future drinking water source. MCLs were identified as a chemical specific standard in the FS.

<u>Safe Drinking Water Act (SDWA) Maximum Contaminant Levels Goals (MCLGs), 40 CFR 141.50</u>

- 141.51. The SDWA MCGLs are health-based criteria promulgated under SARA. The non-zero MCGLs are relevant and appropriate criteria that are to be considered for potential drinking water sources.

RCRA Subtitle C- Releases from Solid Waste Management Units, 40 CFR, Subpart F- 264.95 and 264.96(a) and (c). These regulations are relevant and appropriate as they identify the specific monitoring requirements applicable to hazardous waste facilities. The long-term monitoring program conducted in association with this action will meet the substantive requirements of this ARAR.

In addition, the selected remedy will comply with the following State ARARS:

- Maine Regulations Relating to Surface Water Toxic Control Program (38 M.R.S.A. Section 420, Chapter 530.5). This rule limits the concentrations of certain materials allowed in Maine waters to prevent the occurrence of pollutants in toxic amounts as required by state and federal law. Except if naturally occurring, ambient levels of toxic pollutants shall not exceed the Clean Water Act AWQC.

- Maine Standards for Hazardous Waste Facilities, Miscellaneous Units (06-096 CMR Chapter 854, Section 15) Maximum Exposure Guidelines (MEGs). The Maine MEGs are relevant and appropriate because they are the basis for some of the interim cleanup levels (i.e., the Interim Ground Water Cleanup Levels) for the Site groundwater. The Maine Standards for Hazardous Waste Facilities require that a miscellaneous unit must be closed in a manner that will ensure that hazardous waste shall not appear in ground or surface waters above MEGs. The Site is considered analogous to a miscellaneous hazardous waste unit. The selected remedy is expected to result in groundwater meeting the concentration requirements of the Maine MEGs.

  The recently issued Maine Department of Human Services, Maximum Exposure Guidelines for Drinking Water (MEGs), dated January 20, 2000 will be used as guidance for establishing cleanup levels when MCLs, non-zero MCLGs, and promulgated MEGs (1992) are not available.

- Maine Department of Human Services Rule (10-144 CMR 231-233). These standards are chemical specific ARARs. The Maine primary drinking water standards are equivalent to MCLs. The selected remedy is expected to result in groundwater meeting the concentration requirements of the SDWA as specified as MCLs.

The following policies, advisories, criteria, and guidances (TBCs) will also be considered during the implementation of the remedial action:

- USEPA Response Factor Doses (RfDs). USEPA RfDs were used in the HHRA to characterize risks due to noncarcinogens in various media.

- USEPA Carcinogen Assessment Group CSFs. USEPA CFS was used in the HHRA to compute the individual incremental cancer risk resulting from exposure to carcinogenic compounds.

- USEPA Proposed Rule for Primary Drinking Water Regulations: Arsenic MCL. (Federal Register 6/22/2000, Vol. 65, No. 121, pages 38887-38983). Promulgated MCLs regulate the concentration of contaminants in public drinking water supplies, and are considered relevant and appropriate for groundwater aquifers potentially used for drinking water. The proposed value should be considered a guidance value until it is adopted. Once this proposed regulation is finalized, it will become an ARAR for the Site because it must be met before EPA can determine that the remedy is protective.

3. The Selected Remedy is Cost-Effective

In EPA's judgment, the selected remedy is cost-effective because the remedy's costs are proportional to its overall effectiveness (see 40 CFR 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all federal and any more stringent ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each alternative then was compared to the alternative's costs to determine cost-effectiveness.

From this evaluation, EPA determined that Alternative SML-3 was the most cost effective of the three remedial alternatives as it met the threshold criteria and provided the best balance of the five balancing criteria. SML-3 is the least costly option of three alternatives that meet the cleanup goals because it does not include the capital costs associated with a groundwater extraction system. Moreover, because this option does not include a groundwater extraction system, there are no potential impacts to Sandy Brook caused by groundwater extraction during periods of low flow.

4. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once the Agency identified those alternatives that attain or, as appropriate, waive ARARs and that are protective of human health and the environment, EPA identified which alternative utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The principal threats at the Site were previously addressed as part of the NTCRA. To the extent that the cap installed as part of the NTCRA remains effective, the natural attenuation processes that will occur as part of the selected remedy will cause a permanent reduction in the concentration of contaminants in the groundwater. The selected remedy offers the same amount of protectiveness of Alternatives SML-4 and SML-5 while costing considerably less.

5. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

The selected remedy does not include treatment. The selected remedy is a more cost effective approach that accomplished similar protection to human health and the environment as Alternatives SML-4 and SML-5, which did include treatment. The institutional controls implemented as part of the NTCRA and also required by this ROD, will effectively prevent exposure to groundwater. Since the source of the contamination has been addressed by prior EPA and State of Maine actions, only the residual contamination was the focus of this action. As a result, it was possible to consider alternatives that did not include treatment while still achieving protection of human health and the environment.

6. Five-Year Reviews of the Selected Remedy Are Required

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

N. DOCUMENTATION OF NO SIGNIFICANT CHANGES

EPA presented the Proposed Plan to implement SML-3 for remediation of the Site on August 1, 2000. The source control portion of the remedy has previously been addressed as part of the NTCRA, and the management of migration portion of the preferred alternative includes monitored natural attenuation of groundwater, institutional controls, and long-term monitoring and evaluation of groundwater, surface water, and sediments. EPA reviewed all written and verbal comments submitted during the public comment period from August 2, 2000 through September 2, 2000. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary.

O. STATE ROLE

The MEDEP has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the RI, HHRA, ERA, and FS to determine if the selected remedy is in compliance with applicable or relevant and appropriate State environmental and facility siting laws and regulations. The State of Maine concurs with the selected remedy for the Site. A copy of the declaration of concurrence is attached as Appendix C.